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UNIVERSITY OF MISSOURI.

Francis Potter Daniels: 'The Flora of Columbia, Missouri and Vicinity. An Ecological and Systematic Study of a Local Flora.'

THE ADVANCE OF OUR KNOWLEDGE OF
THE CAUSATION AND METHODS OF
PREVENTION OF STOCK DISEASES
IN SOUTH AFRICA DURING THE
LAST TEN YEARS.

II.

B. PARASITE UNKNOWN.

I. *Rinderpest*.

We now turn our attention to the important diseases of the second group. In these the parasites causing them are unknown—that is to say, no parasites can be detected by the microscope or by culture—but it is equally true that they must be present in the blood and fluids of the sick animals in some form or other. In all probability they are ultra-microscopic—too small to be seen with our present instruments. This is borne out by the fact that they are able to pass through the pores of porcelain filters, which keep back the smallest micro-organisms we are able to recognize.

The first of the second group of diseases is rinderpest, which has overrun and devastated South Africa within the last ten years.

Rinderpest has been known from time immemorial in Europe and Central Asia, and is an exceedingly fatal disease, killing 90 to 100 per cent. of the cattle attacked.

The recent epidemic, according to some, originated in the Nile provinces, and slowly crept southwards, reaching the Transvaal in 1896, after a journey lasting some fifteen years. Great efforts were made to oppose its passage, but nothing seemed to avail. In parts of the country where there were few or no cattle the epidemic spread by means of the wild animals—particularly the buffalo—which have been exterminated in many places.

Ten years ago the symptoms and contagious nature of this disease were well known, but nothing was known as to methods of prevention, and it is to the investigation of this epidemic in South Africa that the discovery of practical methods of immunizing cattle, and in this way of stamping out the disease, is due.

As soon as it was apparent that the epidemic was spreading into South Africa, all the colonies made strenuous efforts to combat it. The Transvaal government invoked the aid of the Pasteur Institute, and Messrs. Bordet and Danysz were sent out to discover some method of prevention. They worked near Pretoria, and were assisted by Dr. Theiler, then the principal veterinary surgeon. Before they arrived on the scene the Natal government had despatched Mr. Watkins-Pitchford, their principal veterinary surgeon, to the Transvaal, where he also at first had Dr. Theiler as his colleague, and where he did some good pioneer work in the serum therapeutics of the disease. In the Cape Colony Dr. Hutcheon, the principal veterinary surgeon, and Dr. Edington, the government bacteriologist, were no less active. It is, however, to Professor Robert Koch, of Berlin, that the honor is undoubtedly due of first publishing a practical method of immunizing cattle against rinderpest. He arrived at Kimberley on December 5, 1896, and in the incredibly short space of time of two months was able to report two methods of immunizing, viz., by the injection of rinderpest bile, and, secondly, by the injection of serum from immune animals. I have always thought that the discovery that the injection of bile taken from an animal dead of rinderpest rendered cattle immune was particularly brilliant. Up to that time no one had dreamt that bile could possess such a quality. It is true that both Transvaal and Orange Free State Boers are said to have

used a mixture of bile and blood from dead animals before Koch's researches, and also that Semmer in 1893 showed that serum might be used for protective purposes; but still to Koch is due the credit of making these processes practical. After he left South Africa his work was continued by Kolle and Turner, who greatly improved the methods; and it is to them, and to the other workers mentioned above, that we owe the fact that rinderpest has now lost its terrors.

In the last recrudescence of this disease in the Transvaal, in 1904, Mr. Stewart Stockman, the principal veterinary surgeon, and Dr. Theiler, thanks to the experience and knowledge gained during the last ten years, were enabled to stamp out the disease rapidly and completely. It is to them also that we owe our knowledge of the dangers of the intensive method of inoculation, much used in the past and due to Kolle and Turner, and the introduction of the fighting against the plague by the inoculation of the healthy cattle by injections of immune serum alone.

In the tsetse-fly disease our advance in knowledge has been in regard to the causation of the disease, and not in its prevention; it is quite otherwise with rinderpest. The contagium or cause of rinderpest is absolutely unknown. We know it exists in the blood, nasal, mucous and other secretions of the sick animal, as all these are infective, but no one has seen it. The smallest quantity of blood will give the disease if injected under the skin of a healthy animal. We also know that the contagium is not very resistant. Blood soon loses its virulence after it leaves the body, and the effect of drying or the addition of chemical preservatives, such as glycerine, acts also injuriously to the contagium, whatever it may be. It evidently belongs to the ultra-visible sort of micro-organisms, as it is said to pass through a porcelain filter.

How the contagium passes from the sick to the healthy is assumed to be by contact. No experiments have, as far as I am aware, been made as to whether it is conveyed by insects as well; but, as Professor John MacFadyen says, as it spreads in all countries and climates and seasons, and the contagium is easily carried on the persons or clothes of human beings, it is improbable that insects have anything to do with it.

It is in the methods of protective inoculation that the great advance has been made in our knowledge of this disease. Ten years ago no means were available to stay the progress of this plague; now it has lost its terrors. As soon as it appears it can be immediately attacked and stamped out. This is done by rendering the surrounding cattle immune to the disease by injecting immune serum. This serum is prepared by taking immune cattle and hyper-immunizing them by the injection of large quantities of virulent blood, so as to make their blood serum as anti-toxic as possible. If there are no immune cattle at hand, cattle can be immunized by Koch's bile injection method and then hyper-immunized; but, of course, in practice—for example, here in the Transvaal—large quantities of immune serum are kept ready for emergencies, and a herd of immune cattle kept up for the supply of the serum. This satisfactory state of affairs, as far as this disease is concerned, is, of course, the outcome of an immense amount of thought and experiment, and I have already mentioned the chief scientific men to whom this country owes this great boon.

Different methods of immunizing have been tried during these years. Up to 1903 the prevailing custom was to use what was known as the virulent-blood and serum method. That is to say, immune serum and virulent blood were injected at the same time, in order that the animal might pass through a modified attack of the dis-

ease. Since 1903, however, in the Transvaal this method has been stopped, and the 'serum alone' method introduced. This method is based on the fact that the virus of rinderpest does not retain its infective property outside the body for more than a day or two; that it dies out in the animal, as a rule, in fourteen days, but in chronic cases only after thirty days, and that, therefore, the healthy cattle in an affected herd must be protected for this length of time. Now 'serum alone' only protects for about ten days, and therefore the cattle must be inoculated three times at intervals of ten days. The doses of serum must also be large—from 50 c.c. to 200 c.c.—so that this method of stamping out rinderpest, although quite efficacious, entails a good deal of labor. It is necessary, then, to spare no expense in making the Veterinary Department efficient, and any cheese-paring legislation in this direction may be disastrous.

II. *Horse-sickness.*

The next stock plague I would bring before your notice is horse-sickness. This is a disease which only affects equines—the horse, mule and rarely the donkey. It is a very fatal disease, carrying off thousands of horses every year. It is one of the most important diseases in South Africa, and, if it could be coped with, would enable the Transvaal to become one of the best horse-breeding countries in the world. At present it is dangerous for any one in Natal and many parts of the Transvaal to possess a valuable horse, the chances of losing it by horse-sickness being so great.

In 1895, when I went to the north of Zululand with the Ingwavuma expedition, we lost all our horses with this disease. We started with a hundred horses, and had to march back on foot, every horse having died.

Ten years ago, when I arrived in South Africa, our knowledge of this disease was

confined to the disease itself; nothing was known as to its causation or prevention. Credit is due to Dr. Edington for having accurately described the lesions and shown its ready inoculability, period of incubation, etc. He, however, fell into the mistake of attributing its causation to a species of mold fungus.

Etiology: Geographical Distribution.—Horse-sickness is widely distributed throughout Africa. It is common in Natal, Zululand, the greater part of the Transvaal, Rhodesia, Bechuanaland and Portuguese East Africa. In Cape Colony it occurs in epidemics, with intervals of ten to twenty years. It is undoubtedly a disease which prevails chiefly in *low-lying localities* and valleys, and is but rarely met with in elevated exposed positions. It, however, is met with now and then in river valleys up to an elevation of some thousands of feet. *Season* has also a remarkable influence on its development, being exceedingly common in summer and disappearing on the appearance of the first frosts of winter.

Ten years ago various theories were held as to the cause of this disease. Some people thought that it was due to eating poisonous herbs; others, to some peculiarity or state of the night atmosphere; others, to eating grass covered with dew; and still others, to the eating of the spiders' webs which may be seen on the grass in the morning. It was known at that time not to be contagious in the ordinary sense of that term; that is to say, a horse could be stabled alongside a case of horse-sickness without incurring the disease, or a horse might be placed without danger in the same stall in which a horse had recently died of horse-sickness.

Nature of the Disease.—A horse which has been exposed to infection shows no signs of the disease for about a week. Its

temperature then goes up rapidly, and it dies after four or five days' illness. Very often the horse appears perfectly well until within a few hours of death. For example, my horse was the last one to die on the Ingwavuma expedition. On the day of his death I rode him until noon without noticing anything amiss. He then became rather dull in his movements, and I handed him over to the groom to lead. He died that evening immediately after we got into camp. It is, therefore, a very rapidly fatal disease, and almost every horse which is attacked by it succumbs. I have never seen a case of horse-sickness which had been brought on by artificial inoculation recover. But there can be no doubt that a small percentage of horses infected naturally do recover, and these recovered horses are, more or less, immune in future to the disease. There is no necessity for me to describe the symptoms of this well-known disease, as every one who has to do with horses in South Africa is perfectly familiar with it, and every one has seen dead horses with the characteristic mass of white foam issuing from their nostrils, due to the effusion of the liquid part of the blood into the lungs and trachea.

Nature of the Virus which causes this Disease.—There can be no doubt that this disease, like the tsetse-fly disease, is caused by some form of blood parasite. A small quantity of fluid taken from any part of a horse suffering from horse-sickness is capable of giving rise to the disease if injected under the skin of a healthy horse. For example, the thousandth part of a drop of blood from a sick horse will, in many cases, give rise to the disease if injected under the skin of a healthy horse. It must be admitted, however, that some horses require a larger dose than others, but it may be said that no horse has yet been found to withstand more than a comparatively small

quantity of infective blood thrown under the skin. Now, although every drop of blood must contain many of the organisms of this disease, yet the most careful examination of such blood under the highest powers of the microscope reveals nothing. Again, if we filter horse-sickness blood through a porcelain filter—a filter which is capable of keeping back all the known visible micro-organisms—the filtrate is found to be virulent. It is evident, then, that we are here dealing with a blood parasite so small in size as to be absolutely invisible to the highest powers of the microscope, and also so minute as to readily pass through the pores of a Chamberlain filter. What the nature of this parasite is one can not tell. It behaves in many curious ways. For example, horse-sickness blood which is simply dried and pounded into powder is found to be perfectly inert. On the other hand, blood kept in the moist condition remains virulent and capable of giving rise to the disease for years. Or, again, the germ of horse-sickness is so resistant to external agencies that if, as described by MacFadyean, a part of the liver of a horse dead from horse-sickness be buried in the ground and subjected to putrefaction, it is found that the liver tissue retains its infectivity for months. Although a very small quantity of blood introduced under the skin of a horse will almost certainly give rise to the disease, it is quite different if the blood is introduced into the stomach. In the latter case a small quantity of blood has no effect, and the horse requires to be drenched with a pint or more before the disease can be given in this way.

The question now arises as to how horses are infected by this disease in nature. On account of the small quantity of blood which will give rise to the disease if injected under the skin, and the large quantity required before the disease can be con-

veyed through the stomach, for a long time it has been supposed that it must be conveyed from sick to healthy horses by means of some biting insect. Experiments have been made within the last few years by Watkins-Pitchford and others in order to clear up this aspect of the question. Horses have been placed in fly-proof shelters in exceedingly unhealthy places, and it was found that in no case did any of these protected horses incur the disease; whereas horses allowed to feed in the same place, but without any shelter, soon succumbed to the disease. But, up to the present, as far as I am aware, the particular biting fly, mosquito or other insect which is the carrier of this disease has not been discovered, and there can be no doubt that one of the most important facts to make out in the etiology of this disease is the discovery of the particular insect which conveys the disease from the sick to the healthy. By this discovery a flood of light may be thrown on the causation of the disease, and some means discovered of combating the disease through the insect, as has been successful in some instances in regard to the case of human malaria.

Professor MacFadyean also suggests that experiments are needed to show what is the 'reservoir' of the virus.

Prevention.—Although we have been unfortunate up to the present in not being able to make out the exact nature of the parasitic cause of this disease, or to discover the exact insect which carries it, a large amount of patient, persevering work has been done within the last ten years in regard to its prevention by protective inoculation.

In this important work Bordet, Edington, Koch, Theiler, Watkins-Pitchford and others have labored for many years, and, according to recent reports, with some measure of success.

Dr. Edington, for example, who has been working at this problem for several years, reports that heart-water is identical with horse-sickness, and that by inoculating mules with heart-water blood he has been able to salt them against horse-sickness. He says that experiments testing this vaccine show it to be an ideal one. It gives a high protection to the animals inoculated. Its keeping powers are excellent. No animal has died as the result of this inoculation, nor has any dangerous symptom been produced. He states that he is not in a position to supply a vaccine for horse-sickness in horses, but has every hope of attaining this successful end very shortly.

We must congratulate Dr. Edington on his results, and trust that this method of conferring immunity may prove itself to be successful when put to practical use. For my part, I am somewhat sceptical of Dr. Edington's methods of immunizing against horse-sickness. I am sure he will forgive my expression of scepticism when I recall to his memory the various methods he has already brought forward, just as optimistically, and which have all been tried and found wanting.

Dr. Koch has lately recommended a method of immunization against horse-sickness. This is the artificial establishment of an active immunity in susceptible animals by gradually increased doses of virulent blood, alternated in the early stages of treatment with the injection of serum prepared from the blood of highly fortified salted horses. Mr. Gray reports that the experiments already conducted on these lines show that the process as laid down by Koch requires important modification before the process of establishing immunity against horse-sickness can be of any practical use.

Mr. Watkins-Pitchford in Natal is also hopeful of succeeding in producing immunity against horse-sickness.

Dr. Theiler, too, reports that he has succeeded in producing a serum which can be utilized in connection with virulent blood to confer active immunity. He informs me that his method is a subcutaneous injection of serum and an intra-jugular injection of virus carried out simultaneously. The death rate in mules, from the effect of the inoculation, he states to be about five per cent. It is higher in horses, but he expects shortly to attain the same result in them. During the last horse-sickness season he exposed 200 immunized mules to natural infection in various parts of the country. Of that number only one died with symptoms of horse-sickness. As Dr. Theiler is himself communicating his method in detail to the association, I need not enter more fully into it.

The man who discovers a practical method of dealing with horse-sickness will be one of the greatest benefactors of this country. There has always been a tradition that a large money reward is awaiting this discovery. I do not know whether this is well founded or not, but certainly such a work would well deserve the highest possible reward. The best reward is to give the successful investigator more opportunity and more assistance in pursuing his beneficent work. The reward given by the French people to Pasteur was the Pasteur Institute; by the German government to Koch, the Imperial Hygienic Institution.

Catarrhal Fever of Sheep: Blue Tongue.—This disease was first described by Hutcheon, the chief veterinary surgeon of Cape Colony.² It is very similar in many respects to horse-sickness. Both these dis-

eases occur most often in low-lying, damp situations, such as river valleys and the coast plain. They also occur at the same time of the year; that is, from January to April. Blue tongue, like horse-sickness, is probably carried from the sick to the healthy by means of some night-feeding insect. At the same time the diseases are not identical, since the inoculation of horse-sickness blood into a sheep does not give rise to blue tongue, nor the blood of the sheep injected into the horse give rise to horse-sickness.

To Mr. Spreuill, government veterinary surgeon in Cape Colony, acting under the advice of Hutcheon, is due the credit of proving that a preventive serum could be prepared capable of immunizing sheep against this disease. Dr. Theiler informs me he has repeated Mr. Spreuill's experiments, and they hope to introduce this method of inoculation at an early date.

Heart-water of Cattle, Goats and Sheep.—This disease was also first clearly described by Mr. Hutcheon. It occurs in the Transvaal, Natal and Cape Colony, and is responsible for much of the yearly loss among the cattle, sheep and goats.

Like the last disease—blue tongue—it resembles horse-sickness in many ways, and, in fact, has been described by Dr. Edington as being identical with it. Like horse-sickness, it is a blood disease with an invisible parasite, so that blood injected under the skin of susceptible animals gives rise to the disease. One difference between the parasites of the two diseases is, that whereas that of horse-sickness is contained in the fluid of the blood, that of heart-water is probably restricted to the red blood corpuscles. The serum separated from the blood is incapable of giving rise to the disease, and the straw-colored pericardial fluid, when injected into susceptible ani-

² It is to Mr. Hutcheon that South Africa owes its knowledge of many stock diseases. For the last twenty-five years he has labored with the utmost earnestness in Cape Colony, often under trying conditions, and his description of the various diseases formed the basis of all the modern work done on the subject.

mals, fails to give rise to any symptoms of the disease. Horse-sickness blood filtered through a porcelain filter is still infective; the opposite holds good up to the present with heart-water. Horse-sickness blood can be kept for years without losing its virulence; heart-water blood loses it in forty-eight hours.

Heart-water has a peculiar distribution, being restricted to the certain tracts of country with a warm, moist climate. It is known to farmers that if they remove their flocks to the high veld the disease dies out.

To Lounsbury is due the credit of explaining these facts. He found that the disease is carried from sick to healthy animals by means of the bont tick, *Amblyomma hebraeum*. This tick leaves its host between each molting, and a larva which sucks the blood of an infected animal is capable of giving rise to the disease in a susceptible animal as either a nymph or imago. The distribution of this tick corresponds to the distribution of the disease. If this tick could be killed off, the disease would disappear from the country. This could doubtless be done on individual farms by long-continued dipping; but in the meantime some method of immunization might be devised.

D. BRUCE.

THE AMERICAN ASSOCIATION FOR THE
ADVANCEMENT OF SCIENCE.

SUMMER MEETING OF SECTION C. GEOLOGY
AND GEOGRAPHY.

THE section of geology and geography (Section E) of the American Association for the Advancement of Science held a summer field meeting at and near Syracuse, N. Y., July 19 to 22, inclusive, in conjunction with the intercollegiate summer courses in geology. Although the attendance was not large, it was fairly satisfactory, and as many participated in the daily excursions as could be cared for con-

veniently on foot. The heat of the early part of the week moderated somewhat by Thursday, the first field day of the meeting, and good weather prevailed during the sessions.

The opening session was held on Wednesday evening in the chapel of the College of Liberal Arts of Syracuse University, and was called to order by the secretary of the section, who introduced as chairman of the meeting Professor William North Rice, of Middletown, Conn., in place of Professor E. A. Smith, of University, Ala., chairman of the section and vice-president of the association for 1905, who was absent on account of his duties as state geologist of Alabama. Addresses of welcome were delivered by Mayor Alan C. Fobes in behalf of the city of Syracuse, by Dean Frank C. Smalley in behalf of Syracuse University and by Dr. John van Duyn in behalf of the University Club. After a felicitous reply by the chairman, Professor T. C. Hopkins, of Syracuse University, briefly outlined the program of work and excursions for the succeeding days and gave a concise sketch of the geology of the vicinity of Syracuse.

On Thursday the members and others in attendance divided for convenience into two parties, one of which, under the guidance of Professor Hopkins, devoted its attention during the morning to problems of stratigraphy near Jamesville, southeast of Syracuse, while the other, under the leadership of Professor H. L. Fairchild, of Rochester, studied the great Railroad Channel and other river channels formed during the recession from central New York state of the ice of the glacial epoch. The two parties met about noon at Green Lake near Jamesville and, after luncheon, listened to an exposition of 'The Local Glacial Features,' by Professor Fairchild. The most striking of these features are the drumlins, which have long been familiar to